VIIRS Corrected Reflectance Science Processing Algorithm (CVIIRS_SPA) User's Guide

Version 1.1

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General

The NASA Goddard Space Flight Center's (GSFC) Direct Readout Laboratory (DRL), Code 606.3 developed this software for the International Polar Orbiter Processing Package (IPOPP). IPOPP maximizes the utility of Earth science data for making real-time decisions by giving fast access to instrument data and derivative products from the Suomi National Polar-orbiting Partnership (SNPP), Aqua, and Terra missions and, in the future, the Joint Polar Satellite System (JPSS) mission.

Users must agree to all terms and conditions in the Software Usage Agreement on the DRL Web Portal before downloading this software.

Software and documentation published on the DRL Web Portal may occasionally be updated or modified. The most current versions of DRL software are available at the DRL Web Portal:

http://directreadout.sci.gsfc.nasa.gov/?id=software

Questions relating to the contents or status of this software and its documentation should be addressed to the DRL via the Contact DRL mechanism at the DRL Web Portal:

http://directreadout.sci.gsfc.nasa.gov/?id=dspContent&cid=66

Algorithm Wrapper Concept

The DRL has developed an algorithm wrapper to provide a common command and execution interface to encapsulate multi-discipline, multi-mission science processing algorithms. The wrapper also provides a structured, standardized technique for packaging new or updated algorithms with minimal effort.

A Science Processing Algorithm (SPA) is defined as a wrapper and its contained algorithm. SPAs will function in a standalone, cross-platform environment to serve the needs of the broad Direct Readout community. Detailed information about SPAs and other DRL technologies is available at the DRL Web Portal.

Software Description

This software package contains the VIIRS Corrected Reflectance Science Processing Algorithm (CVIIRS_SPA). The CVIIRS_SPA creates the VIIRS Corrected Reflectance products by performing simple atmospheric correction with VIIRS visible, near-infrared, and short-wave infrared bands (bands M5, M7, M3, M4, M8, M10, M11, I1, I2, and I3). It corrects for molecular (Rayleigh) scattering and gaseous absorption (water vapor and ozone) using climatological values for gas contents. It requires no real-time input of ancillary data, and performs no aerosol correction. The VIIRS Corrected Reflectance products created by CVIIRS_SPA are based on the 6S Radiative Transfer Model. The SPA functions in two modes: standalone, or as an IPOPP plug-in.

Software Version

Version 1.1 of the DRL algorithm wrapper was used to package the SPA described in this document.

Enhancements to this SPA include:

- improved robustness for handling corrupt or degraded data;

- improved processing results in presence of fill and missing data (of benefit when using H2G SPA);

- ability to process chunked and/or compressed HDF5 input files;

- ability to process Big Endian or Little Endian HDF5 datasets.

This software will execute on a 64-bit computer and has been tested on computers with 32GB of RAM, with the following operating systems:

a) Fedora 18 X86_64;

b) CentOS Linux 6.4 X86_64;

c) OpenSUSE Linux 12.1 X86_64;

d) Kubuntu 13.04 X86_64.

Credits

The Corrected Reflectance algorithm was co-developed by the Land Science Team and the DRL at NASA/GSFC.

Prerequisites

To run this package, you must have the Java Development Kit (JDK) or Java Runtime Engine (JRE) (Java 1.6.0_25 or higher) installed on your computer, and have the Java installation bin/ subdirectory in your PATH environment variable. This package contains 64-bit binaries statically pre-compiled on an x86-compatible 64-bit computer running under Fedora 14, using gcc 4.5.1.

Program Inputs and Outputs

CVIIRS_SPA takes VIIRS SDR and geolocation products (M5, M7, M3, M4, M8, M10, M11, I1, I2, I3, and the M-band terrain-corrected geolocation) as input and produces:

a) a moderate resolution VIIRS corrected reflectance product (containing corrected reflectances in bands M5, M7, M3, M4, M8, M10, M11), and

b) an imagery resolution VIIRS corrected reflectance product (containing corrected reflectances in bands I1, I2 and I3).

Installation and Configuration

Installing as a Standalone Application:

Download the CVIIRS_1.1_SPA_1.1.tar.gz and CVIIRS_1.1_SPA_1.1_testdata.tar.gz (optional) files into the same directory.

Decompress and un-archive the CVIIRS_1.1_SPA_1.1.tar.gz and CVIIRS_1.1_SPA_1.1_testdata.tar.gz (optional) files:

$ tar –xzf CVIIRS_1.1_SPA_1.1.tar.gz
$ tar –xzf CVIIRS_1.1_SPA_1.1_testdata.tar.gz

This will create the following subdirectories:
    SPA
        CVIIRS
            algorithm
            ancillary
            station
            testdata
            testscripts
            wrapper

Installing into an IPOPP Framework: This SPA can also be installed dynamically into an IPOPP framework to automate production of VIIRS corrected reflectance data products. The SPA installation process will install SPA station(s) into IPOPP. An SPA station is an IPOPP agent that provides the mechanism necessary for running an SPA automatically within the IPOPP framework. Once this SPA is installed, users must enable the station(s) corresponding to this SPA along with any other Prerequisite station(s). Instructions for installing an SPA and enabling its stations are contained in the IPOPP User's Guide (available on the DRL Web Portal). The SPA stations associated with this SPA are listed in Appendix A.

Software Package Testing and Validation

The testscripts subdirectory contains test scripts that can be used to verify that your current installation of the SPA is working properly, as described below. Note that the optional CVIIRS_1.1_SPA_1.1_testdata.tar.gz file is required to execute these testing procedures.

   Step 1: cd into the testscripts directory.
   Step 2: There is a script named run-cviirs inside the testscripts directory.

   To run the CVIIRS algorithm, use

       $ ./run-cviirs

A successful execution usually requires 1 minute or more, depending on the speed of your computer and the size of the input. If everything is working properly, the script will terminate

with a message such as:

Output viirs.mcrefl is /home/ipopp/drl/SPA/CVIIRS/testdata/output/CVIIRSM.hdf
Output viirs.icrefl is /home/ipopp/drl/SPA/CVIIRS/testdata/output/CVIIRSI.hdf

You can cd to the output directory to verify that the science products exist. Test output product(s) are available for comparison in the testdata/output directory. These test output product(s) were generated on a 64-bit PC architecture computer running Fedora 14. The output products serve as an indicator of expected program output. Use a comparison utility (such as diff, hdiff, etc.) to compare your output product(s) to those provided in the testdata/output directory. Locally generated files may differ slightly from the provided output files because of differences in machine architecture or operating systems.

If there is a problem and the code terminates abnormally, the problem can be identified using the log files. Log files are automatically generated within the directory used for execution. They start with stdfile* and errfile*. Other log and intermediate files may be generated automatically within the directory used for execution. They are useful for traceability and debugging purposes. However it is strongly recommended that users clean up log files and intermediate files left behind in the run directory before initiating a fresh execution of the SPA. Intermediate files from a previous run may affect a successive run and produce ambiguous results. Please report any errors that cannot be fixed to the DRL.

Program Operation

In order to run the package using your own input data, you can either use the run scripts within the wrapper subdirectories, or modify the test scripts within the testscripts subdirectory.

To Use the Run Scripts

Identify the 'run' scripts: The wrapper directory within this package contains one subdirectory named CVIIRS. The subdirectory contains an executable called 'run'. Execute 'run' within the correct wrapper subdirectory to generate the corresponding product. For instance, the 'run' within wrapper/CVIIRS is used for creating CVIIRS outputs. Note that to execute 'run', you need to have java on your path.

Specify input parameters using <label value> pairs: To execute the 'run' scripts, you must supply the required input and output parameters. Input and output parameters are usually file paths or other values (e.g., an automatic search flag). Each parameter is specified on the command line by a <label value> pair. Labels are simply predefined names for parameters. Each label must be followed by its actual value. Each process has its own set of <label value> pairs that must be specified in order for it to execute. Some of these pairs are optional, meaning the process would still be able to execute even if that parameter is not supplied. The two types of <label value> pairs that the CVIIRS_SPA uses are:

   a) Input file label/values. These are input file paths. Values are absolute or relative paths to the corresponding input file.

   b) Output file label/values. These are output files that are produced by the SPA. Values are absolute or relative paths of the files you want to generate.

The following tables contain labels, and their descriptions, required by the CVIIRS_SPA.

Input File Labels	Description	Source
viirs.svmxx {xx = 03, 04, 05, 07, 08, 10, 11}	VIIRS 750m Mx {x = 03, 04, 05, 07, 08, 10, 11} Band SDR file	1. The C-SDR_SPA or VIIRS-SDR_SPA can be used to create these products. 2. Real time VIIRS SDR and geolocation products over the eastern US region are available from the DRL ftp site at:
viirs.svixx {xx = 01 to 03}	VIIRS 375m Ix {x = 01 to 03} Band SDR file	• ftp://is.sci.gsfc.nasa.gov/gsfcdata/npp/viirs/level1/SVMxx_npp _dyyyymmdd_thhmmssS_ehhmmssS*.h5 {xx = 03, 04, 05, 07, 08, 10, 11}
viirs.gmtco	VIIRS M-band Terrain-Corrected Geolocation file	• ftp://is.sci.gsfc.nasa.gov/gsfcdata/npp/viirs/level1/SVIxx_npp _dyyyymmdd_thhmmssS_ehhmmssS*.h5 {xx = 01 to 03} • ftp://is.sci.gsfc.nasa.gov/gsfcdata/npp/viirs/level1/GMTCO_npp _dyyyymmdd_thhmmssS_ehhmmssS*.h5 Where yyyy, mm, dd represents the year, month, and day of month for the start of the swath; the first hh, mm, ss, S represents the hour, minutes, seconds, and 10th of a second for the start of the swath and the second hh, mm, ss, S represents the end time of the swath. 3. VIIRS SDR and geolocation products for other locations and times are available for download at www.class.noaa.gov

Output Labels	File	Description
viirs.mcrefl		VIIRS Moderate Resolution Corrected Reflectance output HDF file path (daytime only)
viirs.icrefl		VIIRS Imagery Resolution Corrected Reflectance output HDF file path (daytime only)

Execute the 'run': The following script shows an example of a command line to run the CVIIRS algorithm from the testscripts directory:

```
$  ../wrapper/CVIIRS/run \
viirs.svm03 ../testdata/output/SVM03_npp_d20140901_t1738560_e1740201_b14746_c20140908200714455393_noaa_ops.h5 \
viirs.svm04 ../testdata/output/SVM04_npp_d20140901_t1738560_e1740201_b14746_c20140908200714715029_noaa_ops.h5 \
viirs.svm05 ../testdata/output/SVM05_npp_d20140901_t1738560_e1740201_b14746_c20140908200735223402_noaa_ops.h5 \
viirs.svm07 ../testdata/output/SVM07_npp_d20140901_t1738560_e1740201_b14746_c20140908200729256422_noaa_ops.h5 \
viirs.svm08 ../testdata/output/SVM08_npp_d20140901_t1738560_e1740201_b14746_c20140908200803979409_noaa_ops.h5 \
viirs.svm10 ../testdata/output/SVM10_npp_d20140901_t1738560_e1740201_b14746_c20140908200925075349_noaa_ops.h5 \
viirs.svm11 ../testdata/output/SVM11_npp_d20140901_t1738560_e1740201_b14746_c20140908200858348915_noaa_ops.h5 \
viirs.svi01 ../testdata/output/SVI01_npp_d20140901_t1738560_e1740201_b14746_c20140908200814185302_noaa_ops.h5 \
viirs.svi02 ../testdata/output/SVI02_npp_d20140901_t1738560_e1740201_b14746_c20140908200817203819_noaa_ops.h5 \
viirs.svi03 ../testdata/output/SVI03_npp_d20140901_t1738560_e1740201_b14746_c20140908200743066611_noaa_ops.h5 \
viirs.gmtco ../testdata/output/GMTCO_npp_d20140901_t1738560_e1740201_b14746_c20140908200702642321_noaa_ops.h5 \
viirs.mcrefl ../testdata/output/CVIIRSM.h5 \
viirs.icrefl ../testdata/output/CVIIRSI.h5
```

A successful execution usually requires 1 minute or more, depending on the speed of your computer and the size of the input. If execution fails, you will see an error message indicating the cause of failure (e.g., a file cannot be found, or a label cannot be recognized). Correct it and run again. If the problem has some other cause, it can be identified using the log files. Log files are automatically generated within the directory used for execution. They start with stdfile* and errfile* and can be deleted after execution. Other log and intermediate files may be generated automatically within the directory used for execution. They are useful for traceability and debugging purposes. However it is strongly recommended that users clean up log files and intermediate files left behind in the run directory before initiating a fresh execution of the SPA. Intermediate files from a previous run may affect a successive run and produce ambiguous results. The 'run' can be executed from any directory the user chooses. This can be done by prefixing it with the file path for the 'run' script.

NOTES:

1. The VIIRS moderate and imagery resolution corrected reflectance products are not generated during night time.
2. The data products generated by this SPA may be visualized with the DRL's H2G_SPA (Hierarchical Data Format [HDF] to Georeferenced Tagged Image File Format [GeoTIFF] Converter Science Processing Algorithm). H2G is designed specifically for Direct Readout applications to create geolocated GeoTIFF images, jpeg browse images, and png browse images for parameter datasets in SNPP products and EOS products. H2G_SPA and its User Guide are available for download from the DRL Web Portal. Please refer to Appendix A for information on enabling image production for this SPA in IPOPP.

To Use the Scripts in the testscripts Directory

One simple way to run the algorithms from the directory of your choice using your own data is to copy the run-cviirs script from the testscripts directory to the selected directory. Change the values of the variables like WRAPPERHOME, INPUTHOME and OUTPUTHOME to reflect the file paths of the wrapper directories and the input/output file paths. Then modify the input/output file name variables. Run the script to process your data.

Appendix A
SPA Stations

Installation of this SPA in IPOPP mode will make the SPA stations listed in Table A-1 available to IPOPP. These stations along with any other Prerequisite stations (listed in Table A-2) will need to be enabled to allow IPOPP to automate production of the CVIIRS_SPA data products. Furthermore, users who wish to generate image products from the data products generated by this SPA will need to enable the image-generating stations listed in Table A-3. The SPAs containing the prerequisite and the image-generating stations listed in Tables A-2 and A-3 can be downloaded from the DRL Web Portal, in case they are not already available in your IPOPP installation. Details about these other SPAs are available in the respective SPA User's Guides. Please refer to the IPOPP User's Guide for instructions on how to install an SPA in IPOPP and enable the corresponding stations.

Table A-1. SPA Stations

Stations for this SPA	Data Products produced	
CVIIRS	**Product Name**	**Destination (when installed in IPOPP)**
	VIIRS Corrected Reflectance Products	/raid/pub/gsfcdata/npp/viirs/level2/CVIIRSM_npp_d*yyyymmdd*_t*hhmmssS*_e*hhmmssS**.h5* /raid/pub/gsfcdata/npp/viirs/level2/CVIIRSI_npp_d*yyyymmdd*_t*hhmmssS*_e*hhmmssS**.h5*

* Where *yyyy*, *mm*, *dd* represents the year, month and day of month for the start of the swath; the first *hh*, *mm*, *ss*, *S* represents the hour, minutes, seconds and 10th of a second for the start of the swath; and the second *hh*, *mm*, *ss*, *S* represents the end time of the swath.

Table A-2. Prerequisite Stations

Prerequisite SPA stations	SPA in which they are available
VIIRS_C-SDR **OR** **VIIRS-SDR**	C-SDR_SPA VIIRS-SDR_SPA

NOTE: The stations VIIRS-SDR and VIIRS_C-SDR must never be run simultaneously.

Table A-3. Image-generating Stations

Image-generating stations	SPA in which they are available
vcviirs-geotiff	H2G_SPA
vcviirsfire-geotiff	H2G_SPA

NOTES:

1. Please refer to the H2G_SPA User's Guide for more details about the image products, including their locations and filename patterns when they are generated in IPOPP.

2. The vcviirsfire-geotiff station additionally needs VIIRS-AF_SPA to be installed and the "VIIRS-AF" SPA station enabled in IPOPP in order to run. VIIRS-AF_SPA is available for download from the DRL Web Portal in case it is not already available in your IPOPP installation.